RURALS: Review of Undergraduate Research in Agricultural and Life Sciences

Volume 7 | Issue 1 Article 2

October 2012

Influence of Pasture Management Regimes on the Abundance of Four Target Beetle Groups

Christina Doehling
University of Nebraska-Lincoln

Frederick Baxendale
University of Nebraska-Lincoln

Tiffany Heng-Moss
University of Nebraska-Lincoln, thengmoss2@unl.edu

Walter Schacht
University of Nebraska-Lincoln

Cover Page Footnote

The authors would like to thank the Undergraduate Creative Activities and Research Experiences (UCARE) program at the University of Nebraska-Lincoln for providing the funding to support this project. Christina Doehling graduated from the University of Nebraska Insect Science program in 2011 and is currently a pursuing a Doctorate of Chiropractic from the Palmer College of Chiropractic. The faculty sponsors for this project were Dr. Frederick Baxendale, Professor, Department of Entomology and Dr. Tiffany Heng-Moss, Professor, Department of Entomology.

Introduction

Grasslands and pasturelands occupy 236 million hectares (ha) in the 48 contiguous United States, which represents 31% of the total land mass (Lubowski et al. 2006). These grass systems make up 58% of Nebraska's land mass (Dappen et al. 2007). Over 100 species of perennial grasses are used in these grazing systems. Grasses are categorized as warm season or cool season depending on when their peak growth occurs. Cool season grasses are characterized by rapid growth in the moist spring months followed by a semi-dormant period during the hot and dry summer months. They resume growth in late summer and fall when the rains and cooler temperatures return.

Smooth bromegrass (*Bromus inermis* Leyss*)* is an example of a perennial cool-season grass that is widely used in Nebraska pastures. Imported from Eurasia in the early 20^{th} century, smooth bromegrass has become a common cool-season grass species in eastern Nebraska. This grass favors silt or clay loam soils and tolerates the temperate climate associated with the Northern Great Plains (Vogel et al., 1996; Volesky, 2003). Smooth bromegrass spreads by seed dispersion and creeping rhizomes. A fully mature plant is approximately 46-122 cm tall and possesses erect leafy stems (Lamond et al., 1992). Smooth bromegrass can yield a wide range of biomass production (2 - 9 Magnesium (Mg) ha^{-1}) depending on rainfall and the management strategy employed (Hall et al., 2005; Lauriault et al., 2005).

The most common management strategy used in cattle pasture grazing is rotational or deferred rotation which maximizes plant health and growth. Grazing periods are scheduled to correspond with periods of rapid growth followed by periodic rotations. This allows recently grazed plants ample time to recuperate and regrow, and avoids a population shift to undesirable plants. This grazing regime encourages greater plant species richness in the paddock (the fenced feeding area) by reducing competition from dominant species, and by allowing rarer species to be maintained (Petraitis et al. 1989; Caswell & Cohen 1993). Increased plant diversity, in turn, promotes greater insect diversity (Jonas et al., 2002).

In addition to rotational grazing, another important pasture management strategy used to increase smooth bromegrass productivity involves applying fertilizers to enhance foliage growth. Smooth bromegrass grown in eastern Nebraska and fertilized with 90 kg Nitrogen (N) /ha showed significant gains in dry matter productivity when compared to an unfertilized pasture (6.19 to 4.58 Mg ha^{-1}) (Schlueter, 2004). However, because of rising costs of chemical fertilizers, new approaches for introducing N to pastures are being explored. Supplementing cattle feed with high protein dried distiller's grains plus solubles (DDGS) is an innovative way to increase pasture productivity while also increasing steer performance (Watson, et al., 2010). DDGS provides an excellent and inexpensive source of protein, fat, and easily digested fiber. In addition, calves supplemented with DDGS increased the amount of N excreted in their urine (Watson, 2010). This additional N promotes increased forage production which allows pastures with cattle supplemented with DDGS to be stocked at the same rate as pastures that receive inorganic N fertilizers (Watson, 2010).

In Nebraska, cattle are the primary consumers of cool season grass pastures. Cattle have a profound impact on grasslands by consuming vegetation, triggering plant species successions and modifying soil organism activity (Huntly 1991; Morris 1978; Reichman et al. 1993). High levels of grazing can negatively impact insect populations by altering the microclimate of the local plant community by altering light transmission, moisture levels, and temperature. While heavy grazing can reduce grassland productivity, moderate amounts of herbivory, by cattle or insects, can result in increased growth by activating compensatory pathways in plants (Alward & Joern, 1993; Seastedt, 1985). Reduced grazing intensity can also increase the population and species richness of herbivorous insects and their natural enemies (Morris 1981; Morris and Plant 1983, and Watts et al. 1982).

The objectives of this study were to identify the insect orders and families associated with managed smooth bromegrass pastures and determine the influence of three management strategies on the abundance and occurrence of 4 key beetle groups.

Methods and Materials

This study was performed at the University of Nebraska Agricultural Research and Development Center near Mead, Nebraska. Soil in the area is a Sharpsburg silty clay loam. A total of 45.2 cm of rain fell during the sampling period. The predominant vegetation on the site was smooth bromegrass. Fields surrounding the study site were predominately smooth bromegrass pastures.

The study site consisted of 3 smooth bromegrass pastures split into 9 experimental units. The pastures had been under the current management regimes for the previous 5 years. The three pastures were grazed by calves and yearling cows at similar stocking rates between the months of May and October. Spot herbicide treatments were applied to control noxious weeds.

The experimental design was a randomized complete block design with 3 replications of each management regime. One paddock was selected from each replication for sampling. Paddock size ranged from 2.0 – 2.9 ha. Three management regimes were investigated: (1) unfertilized smooth bromegrass, (2) smooth bromegrass fertilized with 90 kg N/ha once during the spring, and (3) unfertilized smooth bromegrass supplemented with 2.3 kg of corn dried distillers grains plus solubles per animal.

Four ground-dwelling beetle groups were selected as target groups based on their ecological roles and relative abundance at the beginning of the sampling season. Two groups, *Cyclotrachelus* (Family: Carabidae) and beetles of the family Histeridae, were selected to represent the predator trophic level, and two genera, *Nicrophorus* (Family: Silphidae) and *Onthophagus* (Family: Scarabaeidae), represented the decomposers.

Three pitfall traps were randomly placed in each paddock. Samples were collected weekly from June 2 until September 2 during the summer of 2010. Pitfall traps were constructed using 474 mL plastic Solo® cups and half-filled with propylene glycol antifreeze to kill and preserve insects (Southwood, 1978). The insects collected in traps were stored in 70% ethyl alcohol until being identified and counted.

Numbers of *Nicrophorus*, *Onthophagus*, *Cyclotrachelus*, and Histeridae were analyzed by mixed model analysis (PROC MIXED, SAS Institute 2002). Means were separated ($P \leq 0.05$) using Fisher's Least Significant Differences (LSD) procedures.

Results & Discussion

Orders & Families Collected

Sixty-one different families of insects, representing nine orders were collected in pitfall traps (Table 1). These results are similar to those reported by Schaeffer (2009). The most abundant group, predatory ground beetles in the genus *Cyclotrachelus*, comprised 71.5% of the target beetles collected. Dung beetles in the genus *Onthophagus* made up 21.3% of the target beetles; while histerid beetles and carrion beetles in the genus *Nicrophorus* made up the remaining 4.9% and 2.3%, respectively.

Table 1. Arthropods associated with managed cool-season grasslands.

Order	Families	Order	Families
Coleoptera	Cantharidae	Hemiptera	Cercopidae
	Carabidae		Cicadellidae
	Chrysomelidae		Coreidae
	Coccinellidae		Lygaeidae
	Curculionidae		Membracidae
	Elateridae		Miridae
	Geotrupidae		Nabidae
	Histeridae		Pentatomidae
	Lampyridae		Rhopalidae
	Meloidae	Hymenoptera	Apidae
	Nitidulidae		Braconidae
	Scarabaeidae		Formicidae
	Silphidae		Halictidae
	Silvanidae		Ichneumonidae
	Staphylinidae		Pompilidae
	Tenebrionidae		Sphecidae
	Trogidae		Vespidae
Collembola	Isotomidae	Lepidoptera	Arctiidae
	Sminthuriidae		Geometridae
Diptera	Asilidae		Lasiocampidae
	Bibionidae		Noctuidae
	Bombyliidae		Nymphalidae
	Calliphoridae		Pieridae
	Dolichopodidae	Neuroptera	Chrysopidae
	Muscidae		Hemerobiidae
	Scatophagidae	Orthoptera	Acrididae
	Statiomyidae		Gryllidae
	Syrphidae		Rhaphidophoridae
	Tabanidae		Tettigoniidae
	Tachinidae	Thysanoptera	Thripidae

Effect of Management Regimes

Cyclotrachelus. Management regime x sampling date two-way interaction was not significant (F= 0.6; df= 26, 84; P= 0.9). Similar levels of *Cyclotrachelus* were found in all three management regimes (F= 0.05; df= 2, 84; P = 0.9). The main effect of sampling date was significant (F= 25.9; df= 13, 84; P < 0.0001).

Onthophagus. Management regime x sampling date two-way interaction was again not significant (F= 1.04; df= 26, 84; P = 0.4). No significant differences in the numbers of *Onthophagus* were found between the management regimes (F= 0.9; df= 2, 84; P = 0.4). There was a significant difference in number of *Onthophagus* among sampling dates (F= 7.1; df= 13, 84; P < 0.0001).

Nicrophorus. The two-way interaction between sampling date and management regime was not significant (F= 0.7; df= 26, 84; P = 0.9). The main effect of the management regime was also not significant (F= 2.8; df= 2, 84; P = 0.07). The main effect of date was again significant (F= 4.3; df= 13, 84; P < 0.0001).

Histeridae. The two-way interaction between sampling date and management regime was not significant (F= 0.9; df= 26, 84; P = 0.7). Similar levels of histerids were found in all three management regimes (F= 0.6; df= 2, 84; P = 0.5). There were significant differences in the number of histerids among sampling dates (F= 4.3; df= 13, 84; P < 0.0001).

Results of this study suggest that any of the three management strategies evaluated could be implemented without negative impacts on the target beetle groups studied. Cattle producers have the option to apply the management regime which best suits their needs without concern for its detrimental effects on the target beetle populations.

Even though this experiment was conducted for only one season, the pastures had been under these same management regimes for the past 5 seasons. If any particular management strategy did have a significant impact on these target beetle populations, the results would have most likely been observed during the sampling process.

Seasonal Activity of Selected Groups

A total of 13,047 *Cyclotrachelus* ground beetles were collected throughout the season. While the numbers of *Cyclotrachelus* were similar overall, beetles in the unfertilized control experienced a spike one week earlier than in the two experimental regimes. After the June 16 sampling date, beetle numbers among the three management regimes remained similar. Overall, beetle numbers exhibited two peaks, a major peak during the week of June 30 and a secondary peak four weeks later on July 28 (Figure 1).

Over the course of the season 3,882 *Onthophagus* were collected. Numbers remained low early in the season until June 30 when the fertilized and supplement treatments experienced a large peak. After the initial spike, however, numbers for all the management regimes returned to the lower levels observed earlier in the season (Figure 2).

A total of 436 *Nicrophorus* (sexton beetles) were collected. Starting June 23, sexton beetle numbers increased in all three management regimes and remained at these levels until July 21 when numbers dropped in all three management regimes. The following week, numbers of *Nicrophorus* in all three management regimes returned to the higher values observed earlier in July. During the week of August 18 and thereafter, numbers in all three management regimes were similar to those seen earlier in the season (Figure 3).

Throughout the experiment 882 beetles from the family Histeridae were collected. Numbers in all management regimes remained relatively low early in the season but increased during the week of July 14 in control and fertilized management regimes. Numbers in the fertilized field experienced a secondary increase 2 weeks later on July 28. After July 28, beetle numbers in all management regimes decreased dramatically and remained low throughout the remainder of the season (Figure 4).

Conclusions

This study provided insights into the insect orders and families association with managed cool-season grasslands. Sixty-one different families of insects, representing nine orders were collected over the course of the sampling season. Results from the management regime study indicate that any of the three management strategies evaluated could be implemented without negative impacts on the four beetle groups investigated.

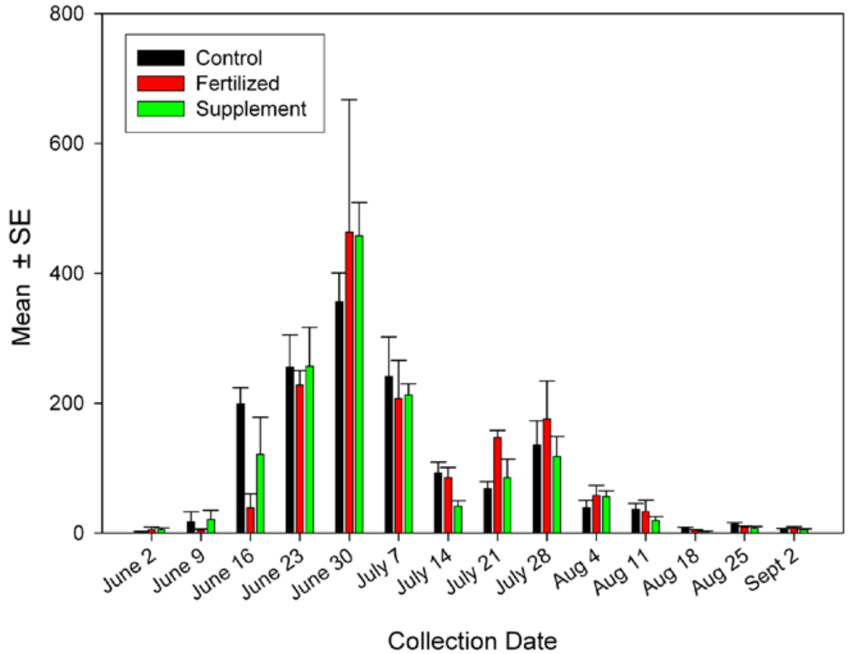

Figure 1. Total numbers of *Cyclotrachelus* collected in pitfall traps during the summer of 2010.

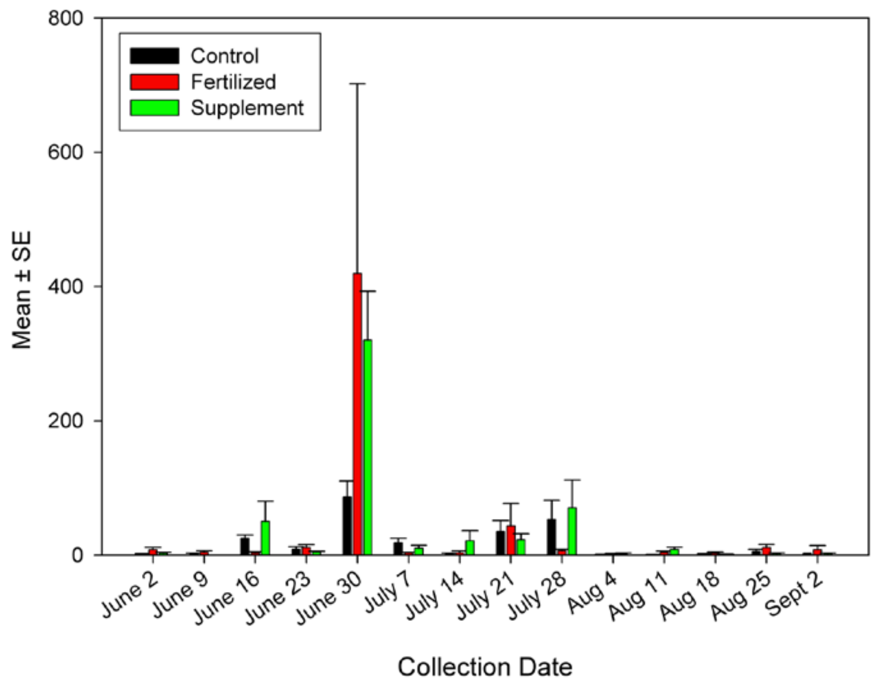

Figure 2. Total number of *Onthophagus* collected in pitfall traps during the summer of 2010.

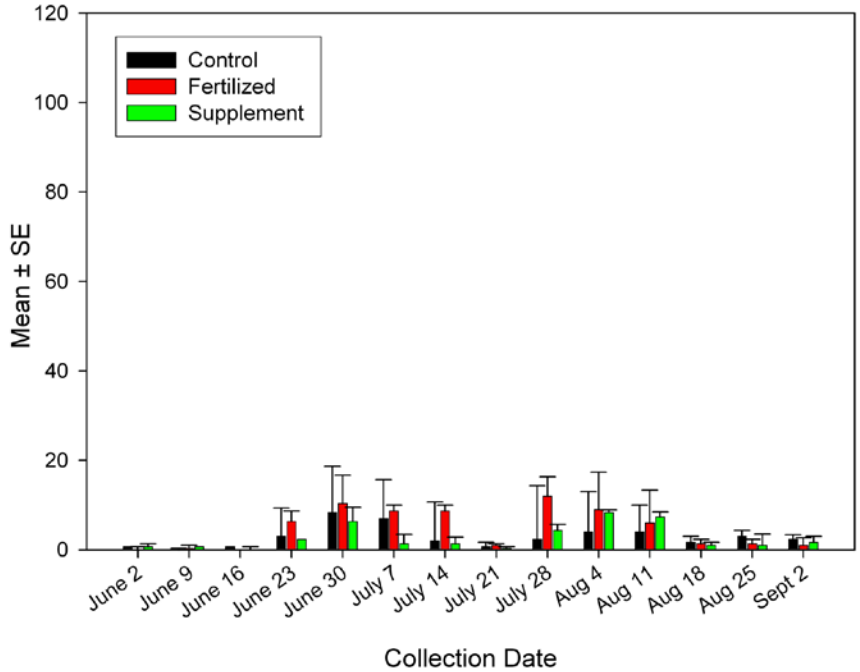

Figure 3. Total number of *Nicrophorus* collected in pitfall traps during the summer of 2010.

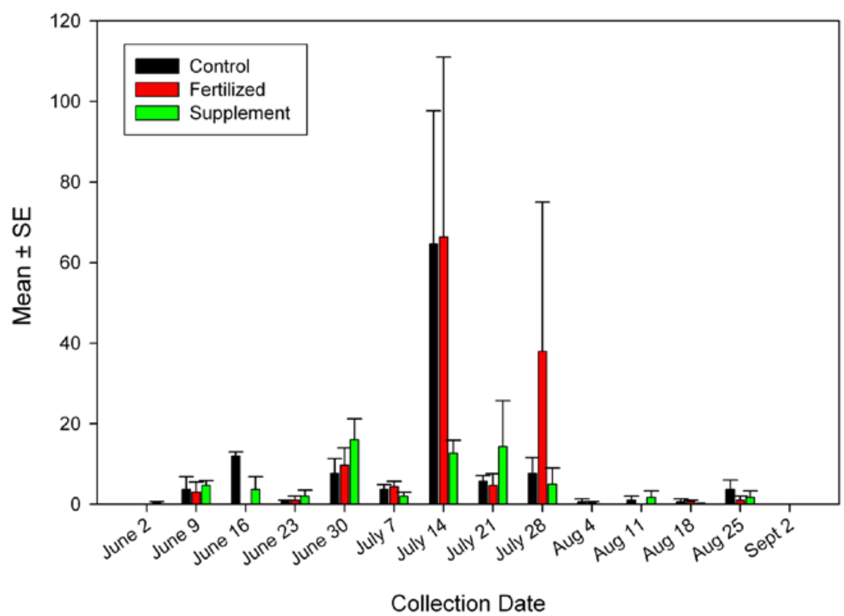

Figure 4. Total number of histerid beetles collected in pitfall traps during the summer of 2010.

Literature Cited

Alward, R. D., and A. Joern. 1993. Plasticity and overcompensation in grass responses to herbivory. Oecologia 95:358-364.

Anderson, N. L. 1961. Seasonal losses in rangeland vegetation due to grasshoppers. Journal of Economic Entomology 54: 369-378

Anderson, N. L. 1972. The assessment of range losses caused by grasshoppers. Proceedings from the International Study Conference of Current and Future Problems in Acridology, 1970 edited by C. F. Hemmings and G. H. C. Taylor pp. 173-179. London Center for Overseas Pest Resistence

Atkinson, C.J. 1986. The effect of clipping on net photosynthesis and dark respiration rates of plants from an upland grassland, with reference to carbon partitioning in Festuca ovina. Ann. Bot. 58:61-72.

Bardgette, R. D. and D. A. Wardle. 2003. Herbivore-mediated linkages between aboveground and belowground communities. Ecology 84:2258-2268

Bernays, E. A. and R. Barbehenn. 1987 Nutritional ecology of grass foliage-chewing insects. In F Slansky and J. G. Rodriguez, editors. Nutritional Ecology of Insects, Mites, Spiders and Related Invertebrates. New York: Wiley

Blosey, B. and T. R. Hunt-Joshi. 2003. Belowground herbivory by insects: influence on plants and aboveground herbivores. Annu. Rev. Entomol. 48:521-47.

Briske, D.D., and J.H. Richards. 1995. Plant responses to defoliation: a physiological, morphological and demographic evaluation. p.635-710. in D.J. Bedunah and R.E. Sosebee (eds.), Wildland plants: physiological ecology and developmental morphology. Soc. for Range Manage., Denver, CO.

Brown, V. K., and A. C. Gange. 1992. Secondary plant succession: how is it modified by insect herbivory? Vegetatio. 101:3-13.

Caswell, H. and J. E. Cohen. 1993. Local and regional regulation of species-area relations: a patch occupancy model. Pages 99-107 in R. E. Ricklefs and D. Schluter, editors. Species diversity in ecological communities: historical and geographical perspectives. University of Chicago Press, Chicago.

Dappen, P., Merchant, J., Ratcliffe, I., and C. Robbins. 2007. Delineation of 2005 land use patterns for the state of nebraska department of natural resources. Lincoln Ne: Center for Advanced Land Management Information Technologies; School of Natural Resources; University of Nebraska-Lincoln http://dnr.ne.gov/Publications_Studies/2005_Landuse_FinalReport.pdf

Dennis, P., Young, M. R., Howard, C. L., and I. J. Gordon. The response of epigeal beetles (Col.: Carabidae, Staphylinidae) to varied grazing regimes on upland *Nardus stricta* grasslands. Journal of Applied Ecology 34:433-443

Finke, D. L., and R. F. Denno. 2004. Predator diversity dampens trophic cascades. Nature 429:407-10

Hall, M. H., Stout, R. C., and A Deak. 2005. Effect of initial harvest timing on cultivar yield in cool- season grass trials. Agron. J. 74:47-51.

Hewitt, G. B., Onsager J. A. 1983 Control of grasshoppers on rangeland in the United States---a perspective. Journal of Rangeland Management. 36:202-207

Hulme, P. E. 1996. Herbivory, plant regeneration, and species coexistence. Journal of Ecology 84:609-615

Hunt, H. W., Coleman, D. C., Ingham, E. R., Ingham, R. E., and E. T. Elliot, et al. 1987. The detrital foodweb in a short grass prairie. Biol. Fertil. Soils 3:57-68

Huntly N. 1991. Herbivores and the dynamics of communities and ecosystems. Annual Review of Ecology and Systematics. 22:477-504

Jonas, J. L., Whiles, M. R., and R. E. Charlton. 2002. Aboveground invertebrate responses ro land management differences in a central Kansas grassland. Environmental Entomology 31:1142-52

Lamond, R. E., Fritz, J. O., and P.D. Ohlenbusch. 1992. Smooth brome production and utilization. Kansas State University Agricultural Experiment Station and Cooperative Extension Services: C-402. Available at: http://oznet.ksu.edu

Lauriault, L. M., Kirksey, R. E., and D. M. VanLeeuwen. 2005. Performance of perennial cool-season forage grasses in diverse soil moisture environments, southern High Plains, USA. Crop. Sci. 45:909-915

Letourneau, D. K., and L. A. Dyer. 1998. Experimental test in lowland tropical forest shows top-down effects through four trophic levels. Ecology 79:1678-87

Lubowski, R.N., Vesterby, M., Bucholtz, S., Baez, A., Roberts, M.J. 2006. "Major Uses of Land in the United States, 2002" USDA Economic Research Service, Economic Information Bulletin Number 14, May 2006

Moore, J. C., and D. E. Walter. 1988. Arthropod regulation of micro and mesobioa in belowground detrital food webs. Ann. Rev. Entomol. 33:419-439

Morris M. G. 1978. Grassland management and invertebrate animals---a selective review. Scientific Proceedings of the Royal Dublin Society Series A 6:247-257

Morris M. G. 1981. Responses of grassland invertebrates to management by cutting. 3. Adverse effects on Auchenorrhyncha. Journal of Applied Ecology 18:107-123

Morris M. G., Plant, R. 1983. Responses of grassland invertebrates to management by cutting. 5. Changes in Hemiptera following cessation of management. Journal of Applied Ecology 20:157-177

Murray, P. J., and D. J. Hatch. 1994. Sitona weevils (Coleoptera: Curculionidae) as agents of rapid transfer of nitrogen from white clover (Trifoloim repens L.) to perennial ryegrass (Loloim perenne). Ann. Appl. Biology 123:29-33

O'Neill, K. M., Olson, B. E., Rolston, M. G., Wallander, R., Larson, D. P., and C. E. Seibert. 2003. Effects of livestock grazing on rangeland grasshopper (Orthoptera: Acrididae) abundance. Agriculture, Ecosystems, and Environment 97:51-64

Pertraitis, P. S., Latham, R. E, and R. A. Niesenbaum. 1989. The maintenance of species diversity by disturbance. Quarterly Review of Biology 64:393-418

Reichman, O. J., Benedix, J. H. Jr, and T. R. Seastedt. 1993. Distinct animal-generated edge effects in tallgrass prairie community. Ecology 74:1281-1285

SAS Institute. 2002. SAS/STAT Software. SAS Institute, Cary, NC.

Schaefer, S. 2009. Characterization of the arthropod community associated with switchgrass (*Panicum virgatum* L.) in Nebraska. Univ. Neb. MS Thesis.

Schlueter, K. R. 2004. Seasonal dry matter and crude protein removal by grazing from grass/legume mixtures. Univ. Neb. MS Thesis.

Seastedt, T. R. and C. M. Tate. 1981. Decomposition rates and nutrient contents of arthropod remains in forest litter. Ecology 62:13-19

Seastedt, T. R. 1985. Maximization of primary and secondary productivity by grazers. Am. Nat. 126:559-564

Shelford, V. E. 1963. The Ecology of North America. University of Illinois Press, Urbana.

Siemann, E., D. Tilman, J. Haarstad, and M. Ritchie. 1998 Experimental tests of the dependence of arthropod diversity on plant diversity. Amercan Naturalist 152:738-750.

Southwood TRE 1978. Ecological Methods. Chapman and Hall, London.

Tashiro H. 1987. Turfgrass Insects of the United States and Canada. Ithaca NY Cornell University Press.

Vogel, K. P., Moore, K. J., and L. E. Moser. 1996. Bromegrasses. P. 535 – 567. *In* L. E. Moser, D. R. Buxton, and M. D. Casler (ed). Cool-season forage grasses. Agron. Monogr. 34. ASA, CSSA, and SSSA, Madison, WI.

Volesky, J.D., Anderson B.E. and J. T. Nichols. 2003. Perrenial forages for irrigated pasture. NebGuide: G1502. University of Nebraska-Lincoln Extension, Institute of Agriculture and Natural Resources (IANR).

Waterhouse, D. F. 1974. The biological control of dung. Scientific American. 230:100-108

Watson, A. K. 2010. Fertilization and supplementation strategies for steers grazing smooth bromegrass pastures. Univ. Neb. MS Thesis.

Watson, A. K., Luebbe, M. K., Klopfenstein, T. J., Erickson, G. E., and W. H. Schacht. 2010. Nebraska Beef Cattle Reports. Supplementing dried distillers grains to growing calves on smooth bromegrass pastures. University of Nebraska–Lincoln.

Watts J. G., Huddleston, E. W., and J. C. Owens. 1982. Rangeland Entomology. Annual Review of Entomology 27:283-311

Whiles, M. R. and R. E. Charlton. 2006. The Ecological Significance of Tallgrass Prairie Arthropods. Annual Reviews in Entomology 51: 387-412.